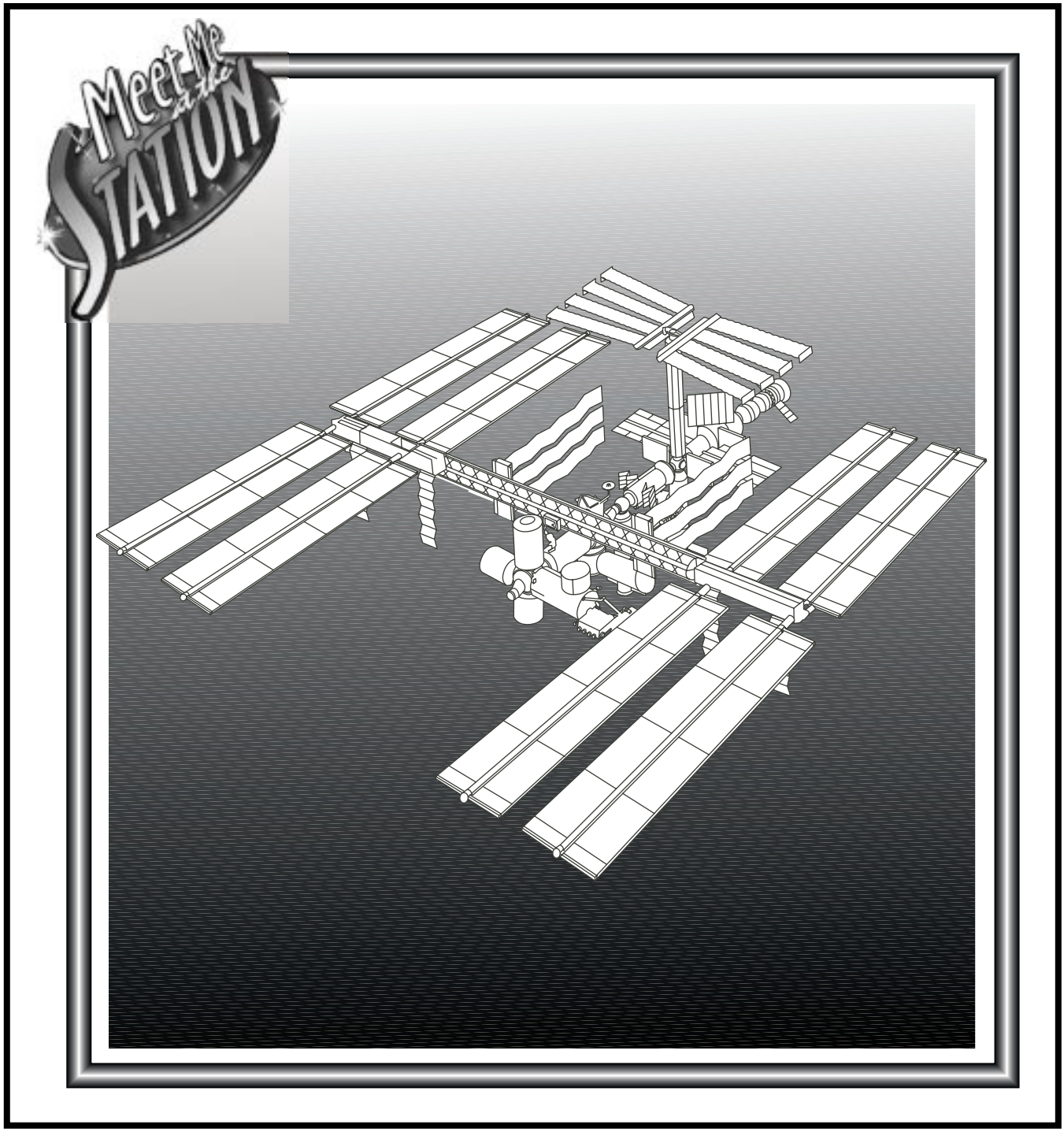
National Aeronautics and
Space Administration

Educational Product	
Educators	Grades 4 - 8

EV-2000-01-001-JSC

Meet Me at the Station:Overview

Video Resource Guide



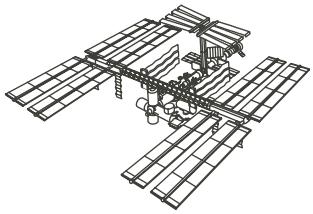
Meet Me At The Station: Overview

Length: 11:47

Description

This program provides an overview of the International Space Station (ISS). Topics discussed include: the history of space stations, who is involved with the ISS project, what the ISS will be used for, dimensions, power supply and the teamwork involved in this multi-national program.

Background



The concept of a human outpost in Earth orbit dates from just after the Civil War. In 1870, American writer Edward Everett Hale published a science fiction tale called "The Brick Moon" in the *Atlantic Monthly*. Hale's human outpost was a navigational aid for ships at sea and proved prophetic. The fictional designers of the Brick Moon encountered many of the same problems with redesigns and funding that NASA would with its Space Station a century later.

In 1903, Russian schoolteacher Konstantin Tsiolkovsky wrote *Beyond the Planet Earth*, a work of fiction based on sound science. In it, he described orbiting space stations where humans would learn to live in space. Tsiolkovsky believed these would lead to self-contained space settlements and expeditions to the Moon, Mars, and the asteroids. Tsiolkovsky wrote about rocketry and space travel until his death in 1935, inspiring generations of Russian space engineers.

Herman Noordung space station

In 1923, Hermann Oberth, a Romanian, coined the term "space station." Herman Noordung, an Austrian, published the first space station blueprint in 1928. Like today's International Space Station, it had modules with different functions. Both men wrote that Space Station parts would be launched into space by rockets.

In 1926, American Robert Goddard made a major breakthrough by launching the first liquid-fueled rocket. This set the stage for the large, powerful rockets needed to launch Space Station parts into orbit. Soviet engineers began work on large rockets in the 1930s. Rocketry advanced rapidly during World War II, especially in Germany, where the ideas of Oberth and Noordung had great influence. The German V-2 rocket, a missile with a range of about 483 km, became a prototype for both U.S. and Russian rockets after the war.

In 1945, renowned German rocket engineer Wernher von Braun came to the U.S. to build rockets for the U.S. Army. In the 1950s, he worked with *Collier's* magazine and Walt Disney Studios to produce articles and documentaries on space flight. In them, he described a wheel-shaped Space Station reached by reusable winged spacecraft. Von Braun saw the Station as an Earth-observation post, a laboratory, and a springboard for Moon and Mars flights.

Meet Me At The Station: Overview

Background (Cont'd)

In May 1955, work began on the Baikonur launch site in Central Asia. In August 1957, the world's first intercontinental ballistic missile lifted off from Baikonur on a test flight. This was followed by the launch of Sputnik 1, the world's first artificial satellite, on October 4, 1957. In response to Sputnik, the U.S. established the National Aeronautics and Space Administration in 1958 and started its first human-in-space-program, Project Mercury, in 1959. On April 12, 1961, Yuri Gagarin lifted off from Baikonur in the Vostok 1 capsule, becoming the first human in space.

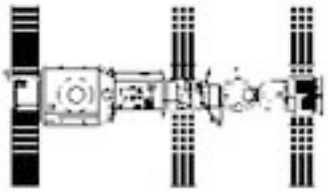
Sputnik

Space Stations (1958-1973)

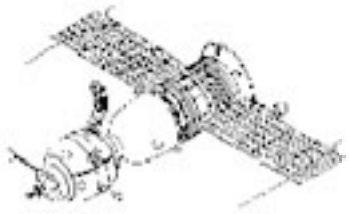
Project Mercury had hardly begun when NASA and the Congress looked beyond it to Space Stations and a permanent human presence in space. Space Stations were seen as the next step after humans reached orbit. Russian and U.S. research into Space Stations continued through the Apollo program and the 1960s. The first Space Station in history, the Russian Salyut 1, reached orbit atop a Proton rocket on April 19, 1971.

The early first-generation Stations were plagued by failures. The crew of Soyuz 10, the first spacecraft sent to Salyut 1, was unable to enter the Station because of a docking mechanism problem. The Soyuz 11 crew lived aboard Salyut 1 for three weeks, but died during return to Earth because the air escaped from their Soyuz spacecraft. Then, three first-generation Stations failed to reach orbit or broke up in orbit before crews could reach them.

The Soviets recovered rapidly from these failures. Salyut 3, 4, and 5 supported a total of five crews. In addition to military surveillance and scientific and industrial experiments, the cosmonauts performed engineering tests to help develop the second-generation Space Stations.



salyut 1



soyuz 11

Skylab (1973-1974)

skylab

In May 1973, the U.S. launched the Skylab Space Station. Skylab was launched atop a Saturn V rocket similar to those that took astronauts to the Moon. The rocket's third stage was modified to become an orbital workshop and living quarters for three-person crews. Non-reusable Apollo spacecraft originally designed for Moon missions ferried astronauts to and from the Station. Skylab hosted three different crews for stays of 28, 56, and 84 days. Skylab astronauts conducted medical tests and studied microgravity's influence on fluids and material properties. The crews also made astronomical, solar, and Earth observations. Long-duration microgravity research begun on Skylab will continue and be refined on the International Space Station. Skylab proved that humans could live and work in space for extended periods. The Station also demonstrated the importance of human involvement in construction and upkeep of orbital assets when the first Skylab crew performed an emergency spacewalk to free a solar array jammed during the Station's launch.

Skylab was not designed for resupply, refueling, or independent reboost. When the last Skylab crew headed home in February 1974, NASA proposed sending a Space Shuttle to boost Skylab to a higher orbit or even to refurbish and reuse the Station. But greater than expected solar activity expanded Earth's atmosphere hastening Skylab's fall from orbit, and Shuttle development fell behind schedule, so Skylab reentered Earth's atmosphere in 1979.

Space Stations (1977-1986)

With the second-generation Stations, the Soviet Space Station program evolved from short-duraton to long-duration stays. Like the first-generation Stations, they were launched without humans on board. Space Station crews arrived later in Soyuz spacecraft. As with the first-generation Stations docking ports permitted refueling and resupply by automated Progress freighters derived from Soyuz. Progress docked automatically at the aft port, and was then opened and unloaded by cosmonauts on the station. Transfer of fuel to the Station took place automatically under supervision from the ground. A second docking port

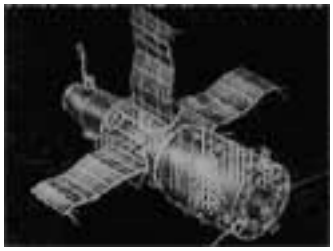
provided a means to change out crews and receive visiting researchers.

Visiting crews often included cosmonaut-researchers from Soviet bloc countries or countries sympathetic to the Soviet Union. Vladimir Remek of Czechoslovakia, the first space traveler not from the U.S. or the Soviet Union, visited Salyut 6 in 1978.

The Salyut 6 Station received 16 cosmonaut crews, including six long-duration crews. The longest on-orbit time for a Salyut 6 crew was 185 days. The Salyut 7, a near twin of Salyut 6, was home to ten cosmonaut crews including six long-duration crews. The longest on-orbit time was 237 days.

NASA deferred plans for a permanent Space Station until after the development of a reusable spacecraft. This spacecraft would provide NASA the capability of returning crews and experiments from a Space Station. By 1979, Space Shuttle development was well advanced. NASA began conceptual studies of a Space Station that would be carried into orbit in pieces by the Space Shuttle.

The Space Shuttle flew for the first time in April 1981, and once again a Space Station was proposed as the next logical step for the U.S. NASA founded the Space Station Task Force in May 1982, which proposed international participation in the Station's development, construction, and operations. In 1983, NASA held the first workshop for potential Space Station users.



salyut 7

space shuttle

Space Stations (1984-present)

U.S. Space Station plans solidified in January 1984, when President Ronald Reagan called for a Space Station in his State of the Union address. He said that the Space Station program was to include participation by U.S. allies.

By the spring of 1985, Japan, Canada, and the European Space Agency each signed a bilateral memorandum of understanding with the U.S. for participation in the Space Station project. In May 1985, NASA held the first space station international user workshop in Copenhagen, Denmark.

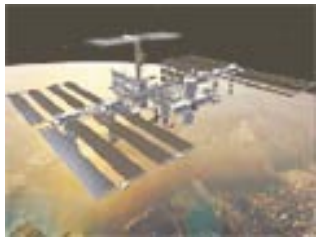
By mid-1986, the partners reached agreement on their respective hardware contributions. Canada would build a remote manipulator system similar to the one it had built for the Space Shuttle, while Japan and ESA would each contribute laboratory modules. Formal agreements were signed in September 1988. These partners' contributions remain generally unchanged for the International Space Station.

During this same time period, Russia began construction of Mir, the first long duration space station. Mir weighs more than 100 tons and has been in orbit for 14 years.. An important goal of the Mir program has

MIR SPACE STATION

Shuttle Mir Program

Russian FGB



International Space Station

been to maintain a long duration human space presence. Russian cosmonauts have lived aboard Mir continuously for more than a decade, demonstrating proven experience in Space Station operations.

In 1988, Reagan gave the U.S. led Space Station a name–Freedom. Space Station Freedom's design underwent modifications with each annual budget cycle as Congress called for its cost to be reduced. The truss was shortened and the U.S. Habitation and Laboratory modules reduced in size. The truss was to be launched in sections with subsystems already in place. Despite the redesigns, NASA and contractors produced a substantial amount of hardware. In 1992, the U.S. agreed to buy Russian Soyuz vehicles to serve as Freedom's lifeboats (these are now known as Soyuz crew return and transfer vehicles) and the Shuttle-Mir program (now International Space Station Phase I) got its start.

In 1993, President William Clinton called for the station to be redesigned once again to reduce costs and include more international involvement. To stimulate innovation, teams from different NASA centers competed to develop three distinct station redesign options. The White House selected the option dubbed Alpha.

After the Russians agreed to supply major hardware elements, many originally intended for their Mir 2 space station program, the Station became known as the International Space Station. Assembly began with the launch of the Russian Zarya-made (FGB), a propulsion module that provides guidance, control, and orbit maintenance for the Station as it grows, permitting expansion to basic operational capability much earlier than Freedom. This offers new opportunities to all the Station partners by permitting early scientific research.

The International Space Station (ISS) is the largest and most complex international scientific project in history. The ISS draws upon the scientific and technological resources of 16 nations: United States, Canada, Japan, Russia, 11 nations of the European Space Agency, and Brazil.

The first phase of the ISS, the Shuttle-Mir Program, began in 1995 and involved more than two years of continuous stays by astronauts aboard the Russian Mir Space Station and nine Shuttle-Mir docking missions. Knowledge was gained in technology, international space operations and scientific research.

The ISS will establish a laboratory complex in orbit, more than four times the size and with almost 60 times the electrical power for experiments critical for research capability of Russia's Mir. Research in the Station's six laboratories will lead to discoveries in medicine, materials and fundamental science that will benefit people all over the world. Through its research and technology, the Station also will serve as an indispensable step in preparation for future human space exploration.

Components of the ISS are nearing completion at factories and laboratories in the United States and worldwide. Orbital assembly of the ISS begins a new era of hands-on work in space, involving more spacewalks than ever before and a new generation of space robotics.

Meet Me At The Station: Overview

The Space Shuttle and two types of Russian launch vehicles will launch at least 46 missions to assemble the Station. Of these, at least 36 will be Space Shuttle flights. The first crew to live aboard the ISS, comprised of a U.S. astronaut as commander accompanied by two Russian cosmonauts, will be launched in early 2000 on a Russian Soyuz spacecraft.

When it is completed, the ISS will house an international crew of up to seven for stays of three to six months. Emergency crew return vehicles will always be docked with the ISS while it is inhabited, to assure the return of all crewmembers. Initially, a Russian Soyuz spacecraft, which has a crew capacity of three, will be used. Two Soyuz spacecraft will be required when the crew sizes increase to six. Later, a higher capacity, U.S.-built vehicle, now under development as a prototype called the X-38, will allow a crew of up to seven people to return to Earth.

X-38 crew return vehicle

For further information, visit the Space Station web site at: http://spaceflight.nasa.gov or the NASA History website at http://history.nasa.gov

International Space Station Facts and Figures

Wingspan End-to-End Width	108.6 meters
Length	79.9 meters
Mass	~456,620 kilograms
Operating Altitude	407 kilometers (average)
Inclination	51.6 degrees to the Equator
Atmosphere	101.36 kilopascals (same as Earth at sea level)
Crew Size	Up to seven people

International Space Station Terms

Truss – a backbone-like metal structure located on the outside of the Space Station. The truss is used to support and connect the components of the Space Station.

International Space Station Facts and Figures (Cont'd)

Photovoltaic Array – collects light from the Sun and uses it to make electricity to power the equipment and experiments on the Space Station.

Laboratory Module – where most of the equipment used for conducting scientific and technological research is located.

Nodes – used to attach one module to another and serve as passageways so that the astronauts can go between modules. The nodes are also used for conducting some experiments and for storage.

Habitat Module – where the astronauts cook, eat, sleep, bathe, exercise and relax.

Radiator – removes heat generated by on board systems.

Activity One: A Sign of the Times

Objectives

The students will:

- Determine and investigate events in the development of Space Stations.
- Create a timeline of the development of Space Stations.
- Research historical events and compare them to dates on a Space Station timeline.
- Analyze the information to interpret the technological developments necessary for Space Stations.

Standards

Science

Science in Personal and Social Perspectives
History and Nature of Science

Geography

Physical and Human Characteristics of Places

Materials

Poster board or construction paper
Rulers
String
Old Magazines
Colored Markers

Activity One: A Sign of the Times (Cont'd)

Procedure

Review what a time line is and why it is an important way of displaying information. Discuss the time line shown in the video. Explain to the students that they are going to investigate events that led to the development of Space Stations. Following the investigation, students will create a timeline that shows important people and events in Space Station development. Students may work individually, in pairs, or small groups. Students will need to decide how to display their events on the timeline. (Possible choices include drawings, pictures, models, and magazine cutouts.) Have the students present the information from their investigations to the rest of the class. Collect the items and have students place them on the timeline. The timeline can be hung from the ceiling, attached to a wall or put on a shelf or table. As a class, discuss the sequence of events and identify those that were critical for the development of Space Stations to proceed. Compare these to the development of technology i.e., silicon chips, transistors, computers, propulsion, etc.

Use the following events to get started or have students determine important events based on their research.

1870 American writer Edward Everett Hale published a science fiction tale called “The Brick Moon” in the *Atlantic Monthly.*

1903 Konstantin Tsiolkovsky wrote *Beyond the Planet Earth.*

1923 Hermann Oberth coined the term “Space Station.”

1927 Robert Goddard launched the first liquid-fueled rocket.

1928 Herman Noordung published the first Space Station blueprint.

1942 German V-2 rocket developed and used.

1945 Wernher von Braun came to the U.S. to build rockets for the U.S. Army.

1952 In *Collier’s* magazine articles, Wernher von Braun described a wheel-shaped Space Station reached by reusable winged spacecraft.

1955 Work began on the Baikonur launch site in central Asia.

1956 The world s first intercontinental ballistic missile lifted off from Baikonur.

Activity One: A Sign of the Times (Cont'd)

1957 Sputnik 1 launched from Baikonur.

1961 Yuri Gagarin launched in the Vostok 1 capsule, becoming the first human in space.

1969 Neil Armstrong and Buzz Aldrin became the first humans to walk on the Moon.

1971 The first Space Station in history, the Russian Salyut 1, reached orbit atop a Proton rocket.

1973 The U.S. launched the Skylab Space Station atop a Saturn V rocket.

1974-1977 Salyut 3, 4 and 5 launched (also known as Almaz Station).

1977 Salyut 6 launched.

1982 Salyut 7 launched.

1984 President Ronald Reagan called for a Space Station that includes participation by U.S. allies.

1985 Japan, Canada and the European Space Agency each signed a bilateral memorandum of understanding with the U.S. for participation in the Space Station project.

1986 Space Station Mir initial element launched.

1988 Formal agreements were signed between the U.S. and its Space Station partners.

1992 Russia joined the U.S. and its partners in the International Space Station Program.

1995 The Shuttle-Mir Program, the first phase of the ISS, began.

1998 The first two elements of the ISS, Zarya and Unity, launched from Russia and the U.S.

Assessment

1. Evaluate student produced products and participation.

Activity Two: Where is the International Space Station?

Objective
The student will:
- Build a model that demonstrates the relative distance between Earth and the orbiting International Space Station (ISS).

Standards
Science
- Unifying Concepts and Processes

Mathematics
- Mathematical Connections
- Number and Number Relationships
- Computation and Estimation
- Algebra
- Measurement

Geography
- The World in Spatial Terms

Materials
Classroom globe
Paper
Pencil
Ruler and/or tape measure
Calculator

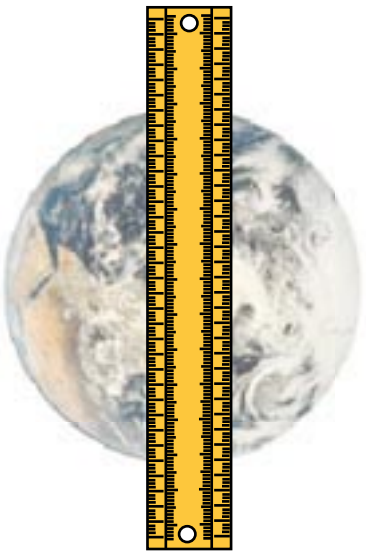
Procedure
1. Have students bring in models (i.e. cars, dolls, and airplanes). Discuss how a model represents an object. What information does it communicate? (*Texture, color, shape etc.)*

2. Have students list the advantages of using a model over a life-size object. (*Small and portable, allows designs to be tested before a full scale design is built. May save time and money).*

3. Discuss with students that the globe used for this activity is a model of the Earth.

4. Have students measure the diameter of the globe being used.

5. The approximate diameter of Earth is equal to 12,875 km. Therefore, the measurement of the diameter of the globe represents 12,875 km.



Activity Two: Where is the International Space Station? (Cont'd)

6. The orbital altitude of the ISS is approximately 402 km.

7. Using the scale model, have students calculate the altitude of the ISS (x represents the altitude of the ISS on the scale model) using the following formula:

$$\frac{402 \text{ km}}{12{,}875 \text{ km}} = \frac{x}{\text{Model's diameter in cm}}$$

8. Have students devise a method for demonstrating the relative altitude of the ISS on the globe. *Suggestions: (a) students can use a piece of paper cut to the correct length and taped to the globe, or (b) stack a small amount of clay on the globe, or (c) layer several pieces of paper.*

Extensions

1. Add to the model by calculating the scale altitude of commercial airlines (10,600 m) and geostationary satellites (36,000 km).

2. The elevation of Mt. Everest is 8,850 meters. Have students calculate the distance separating the ISS and the summit of Mt. Everest.

3. The orbital altitude of the Moon is approximately 402,325 km (about 1,000 times) further away from Earth than the International Space Station. Use the classroom globe to have students calculate the relative distance between Earth and the Moon. Make a model using the classroom globe. Compare the relative distances from Earth of the ISS and the Moon.

Assessment

Have students draw a circle on a piece of paper that represents a model of Earth. (Hint: a circle 15 cm or larger works best.) Using the same procedures as above, calculate the relative altitude of the ISS. Complete the model by having students place a symbol representing the ISS near the circle showing the relative distance of the ISS from Earth.

Activity Three: Team Patch

Objective
The students will:
- Simulate the decision making process facing the ISS International Partners.
- Participate in a team effort to design a Space Station patch.
- Research cultural aspects of the ISS International Partners

Standards
Geography
Human Systems
Uses of Geography

Materials
Poster board
Construction paper
Crayons, colored pencils and markers

Procedures
Pre-Activity:
Have students bring to school examples of business and professional logos and symbols (students may want to cut examples out of magazines or bring actual articles i.e., soft drink can). Discuss with students the information conveyed by the logos and symbols.

Activity:
Divide the class into five groups. Assign each group one of the Partner agencies involved in the International Space Station Project (Canadian Space Agency, European Space Agency, National Aeronautics and Space Administration, National Space Development Agency of Japan, Russian Space Agency). Have students research for information on their assigned space agency. Include cultural aspects of the Partner countries in the research. Pay particular attention to each Partner's unique contribution to the ISS.

A good place to find up-to-date information is the Internet:

Canadian Space Agency (CSA)
http://www.space.gc.ca/

European Space Agency (ESA)
http://www.esrin.esa.it/

National Institute for Space Research (Brazil)
http://www.inpe.br/

Activity Three: Team Patch (Cont"d)

National Aeronautics and Space Administration (NASA)
http://spaceflight.nasa.gov

National Space Development Agency of Japan (NASDA) -
http://www.nasda.go.jp/index_e.html

Russian Space Agency (RSA)
http://www.rka.ru./

Each group will be responsible for designing a patch for their agency. The patch should include:
- an icon that represents their space agency
- a motto that defines their agency's goals and/or mission
- a shape of approximately 16 square inches (circle, triangle, square, rectangle etc.).
- at least three colors

Students may also want to do some research on existing NASA and Space Shuttle patches (http://spaceflight.nasa.gov). Have students design their patch using the information they have gathered. Have each group present their designs to the entire class.

Once the presentations have been completed, have each group design a patch or flag for the ISS. The ISS patch/flag should represent all of the partners and should include:
- an icon that represents all of the partner countries
- a motto that defines the ISS's goals and/or mission
- at least three colors

Have each group present their designs to the entire class. Have the class devise a method for determining which design is selected (students could hold an election or conduct a secret ballot).

Assessment

1. Evaluate student-produced products and participation.

Meet Me at the Station: Overview
Video Resource Guide and Videotape

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Please take a moment to respond to the statements and questions below. You can submit your response through the Internet or by mail. Send your reply to the following Internet address:

http://ehb2.gsfc.nasa.gov/edcats/educational_videotape

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Otherwise, please return the reply card by mail. Thank you.

1. With what grades did you use the video resource guide and videotape?
   Number of Teachers/Faculty:

   _____ K-4 _____ 5-8 _____ 9-12 _____ Community College
   College/University - _____ Undergraduate _____ Graduate

   Number of Students:

   _____ K-4 _____ 5-8 _____ 9-12 _____ Community College
   College/University - _____ Undergraduate _____ Graduate

   Number of Others:

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   _____General Public _____ Civic Groups _____ Other

2. What is your home 5- or 9-digit zip code? __ __ __ __ __ — __ __ __ __

3. This is a valuable video resource guide and videotape?

   ❑ Strongly Agree ❑ Agree ❑ Neutral ❑ Disagree ❑ Strongly Disagree

4. I expect to apply what I learned in this video resource guide and videotape.

   ❑ Strongly Agree ❑ Agree ❑ Neutral ❑ Disagree ❑ Strongly Disagree

Fold along line and tape closed.

5. What kind of recommendation would you make to someone who asks about this video resource guide and videotape?

   ❑ Excellent ❑ Good ❑ Average ❑ Poor ❑ Very Poor

6. How did you use this video resource guide and videotape?

   ❑ Background Information
   ❑ Critical Thinking Tasks
   ❑ Demonstrate NASA Materials
   ❑ Demonstration
   ❑ Group Discussions
   ❑ Hands-On Activities
   ❑ Integration Into Existing Curricula
   ❑ Interdisciplinary Activity
   ❑ Lecture
   ❑ Science and Mathematics Standards Integration
   ❑ Team Activities
   ❑ Other: Please specify:

   _____

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   _____

8. What features of this video resource guide and videotape did you find particularly helpful?

   _____
   _____
   _____

9. How can we make this video resource guide and videotape more effective for you?

   _____
   _____
   _____

10. Additional comments:

    _____
    _____
    _____

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